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A broadband low frequency radio telescope at Gauribidanur

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Abstract : A broadband radio telescope operating at decametre wavelengths built at Gauribidanur (latitude 13° 36′ N, longitude 77° 27′ E) India, primarily for the study of solar radio emission, is described.

Key words : radio telescope—solar radio emission—Gauribidanur

1. Introduction

A broadband radio telescope operating at decametre wavelengths has been built at Gauribidanur (latitude 13° 36′ N, longitude 77° 27′ E) primarily for the study of solar radio emission. It will also be useful for the studies of scintillations, pulsars, and radio recombination lines. It is a meridian transit instrument operating in the frequency range 35–70 MHz. The essential requirements for studies of solar radio emission are (i) wide bandwidth, (ii) high sensitivity, (iii) long observing time, and (iv) resonable angular resolution.

2. Antenna system

The basic element of the antenna system is a biconical dipole made up of copper wire of gauge 16, and has a bandwidth of 40 MHz. Its impedance is 600 ohms and VSWR is < 2 in the frequency range of 35 MHz to 70 MHz. The dipoles accept north-south polarization. The array consists of 64 elements arranged in a matrix of 4×16 along east-west and north-south respectivly.

There are four elements in the east-west direction with an interelement spacing of 10 m. These are combined together in a branched feeder system using RG 8U cable and 2 : 1 transformers. There are 16 such rows in the north-south direction. The 16 elements in one column are placed in a square corner reflector with interelement spacing of 4 m. The corner reflector is made up of galvanized iron wires spaced 20 cm running in the NS direction. The sides of the corner are 10 m in length which is greater than one wavelength at the lowest frequency of operation. The apex distance between the corner and the element is 2 m which is 0.25λ to 0.7λ in the frequency range 35–70 MHz. The expected gain of the element when placed in a corner reflector of such size and spacing is 10dB over a half wavelength dipole. The output of each row is amplified by a broadband amplifier of 13 dB gain and is brought to control hut using RG 8U coaxial cable.

The array is split up into northern and southern groups of eight rows each. The eight rows of each group are combined in a branched feeder system and delay shifters are introduced at appropriate places. These delay shifters are used to steer the response of the array to ± 45° of the zenith in the NS direction. The delays are made up of different length of RG 174 cable. They are switched in or out to compensate for the path length difference for a source at a desired declination. The switches are made up of diodes and compensatory networks. The positions of the beam formed is independent of frequency, allowing simultaneous observation of a radio source over the full system bandwidth. The beamwidths and the observing time at various frequencies are listed in table 1. The effective collecting area is

Table 1. The beamwidths the observing time at verious frequencies

Frequency MHz	HPBW		Observing time min
	EW	NS	
36.25	12.27	7.6	50
45.7	9.55	5.96	38
55.5	7.85	4.88	31
64.25	6.61	4.13	26

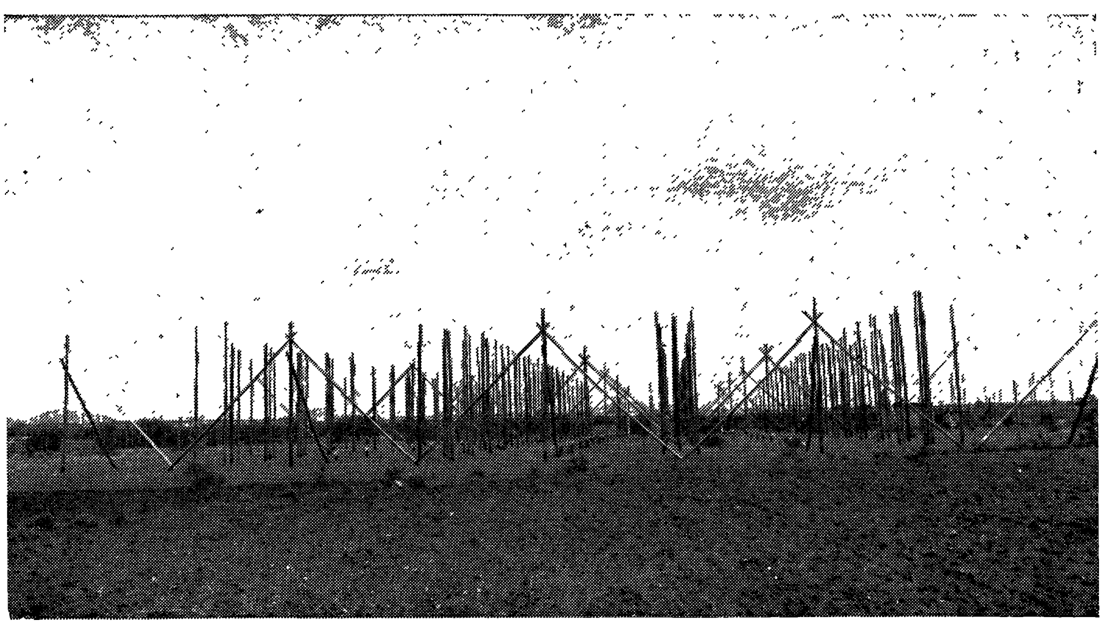

Figure 1. Photograph of the broadband antenna system.

$\sim$ 2000m^2 and sensitivity is better than 100Jy at 65 MHz for a 1 MHz bandwidth and integration time of 1s. A photograph of the array is shown in figure 1.

3. Receiver system

The signal outputs from the north and south groups are amplified after they pass through the delay shifting network, using broadband amplifiers (gain 35 dB). The signals are then sent through buried coaxial cables of 0.8 km length to the main receiver building. Here both the north and south outputs are split into four channels each centred around 35, 45, 55, and 65 MHz. The signals at the corresponding frequencies are then correlated using conventional phase switching receivers. The predetection bandwidth is 1 MHz at all frequencies. The time constant ranges from 100 ms to 1 s. The correlated outputs are recorded both in analog and digital form.

4. Observations

The radio telescope is used essentially for three programs at the present time. They are : (i) Studies of the continuum emission from the undisturbed sun; (ii) fine structure of solar radio bursts; and (iii) scintillation of radio sources. Figure 2 shows the scan of the continuum emission from the undisturbed sun at four frequencies obtained on 1985 November 8. Such scans are calibrated using the responses from point sources of known flux densities which lie close to the position of the sun. The point sources used are 3C144 (Tau A) during June and 3C274 (Virgo A) during August of each year. During the period 1985 May–September, we have determined the radio spectrum on several days on which accurate calibration can be made and found that the spectral index α ($S_\gamma \propto \gamma^\alpha$) varies in the range

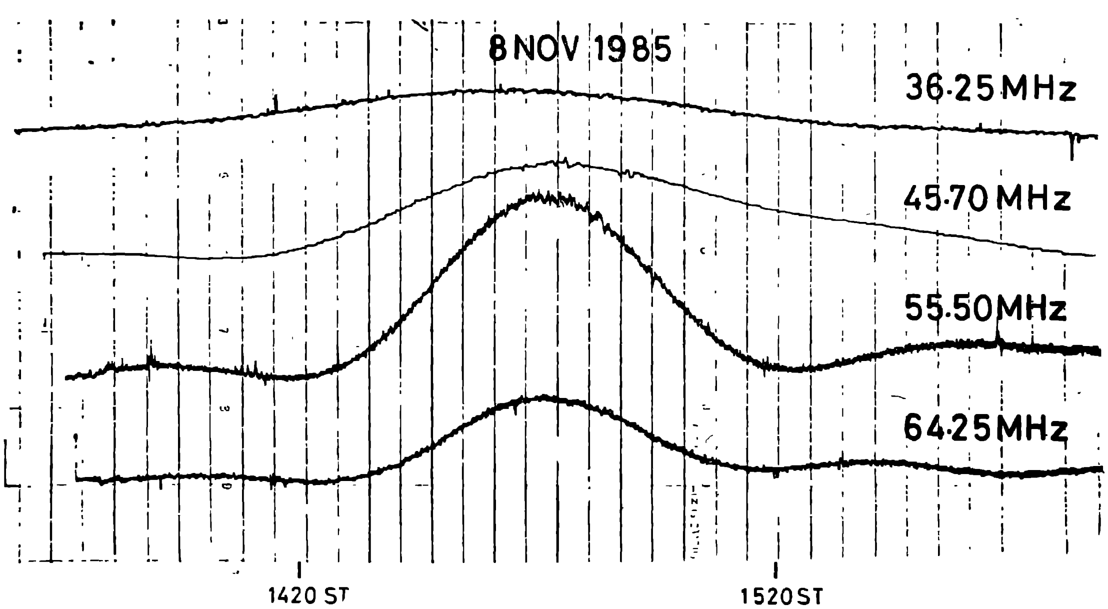

Figure 2. Analog records of the continuum emission from the undisturbed sun.

of + 0.7 to + 4.1. These results are interpreted in terms of the existence of temperature gradient in the outer corona (Subramanian & Sastry 1986). Figure 3 shows a typical solar radio burst record obtained on 1985 May 11. One can see a type III burst at all frequencies. Note the progressive time shift of the peak of the emission from high (64.25 MHz) to low (36.25 MHz) frequencies. Note also the type IIIb burst ahead of the type III burst at 36.25 MHz. We propose to study the time profiles of these bursts at various frequencies.

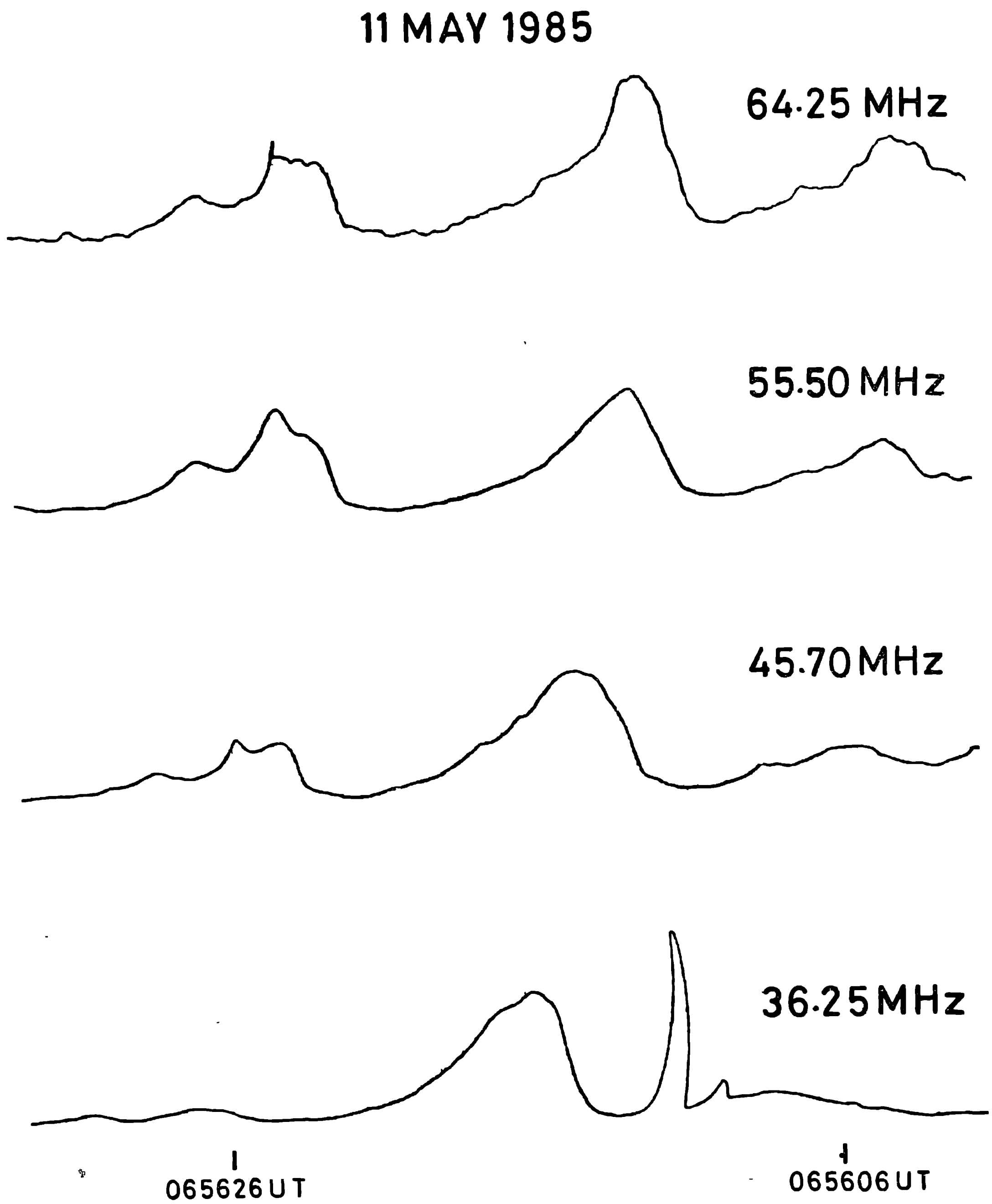

Figure 3. Analog record of radio bursts from the sun at various frequencies.

The scintillations of radio sources both in interplanetary medium and ionosphere are also being studied. The results of these studies will be published elsewhere.

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Reference

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